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THE TECHNIC.

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NOTICE TO SUBSCRIBERS.

Hereafter we shall follow the general rule regarding subscriptions, and shall continue sending THE TECHNIC to subscribers until notified to discontinue.

TWO new names appear in the Board of Editors this month. At the last meeting Mr. Butler, '99, was elected to fill the place left vacant by the resignation of Mr. Insley, '00, of the Exchange Department. We regret to see Mr. Insley retire from his position, but the extra work he is carrying, outside of his school duties, makes it necessary for him to resign from THE TECHNIC.

The Freshman representative in the Local Department is always elected at the beginning of the winter term, and Mr. Miller will hereafter be pleased to receive the confidence of all his class and they may be sure he will lend a ready ear to all their tales of woe, and perchance he may gather a few of the witticisms in which the Freshmen are given to indulge.

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MUCH inconvenience has been caused by the exchanges being taken from the table and even from the mail box, before the Exchange Editor has had a chance to review them.

The papers, after they have been placed on the table, are for the public to read, but not to be carried away or mutilated by having the supplements taken out or clippings made. It seems unnecessary to mention this, but we find that some one has been taking the pictures and a number of the papers are missing. Often it makes little difference if the papers are clipped after they have been reviewed, but it is not right to the other students to mutilate the papers to such an extent that they are almost valueless, so we must request that they be handled as carefully as possible and that the mail will not be disturbed until it has been opened by the proper person, after which the magazines will be placed on the center table where all are welcome to use them.

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TO all who are lovers of art, the collection of pictures exhibited in the Drawing Room can not fail to be deeply interesting, as they are copies of the works of some of the best artists of both this country and Europe.

The collection, which has been secured for the

Institute, is one of the sets published by the *Ladies' Home Journal*, being reproductions of the finest illustrations which have appeared in that magazine in the last few years, and are made by a special process which gives all the beauty and life of the original.

There are fifty pictures by well known artists, and all who are fond of art will find in these copies much to be admired and many points may be brought to the student if he will carefully study the work and style of the artists. Each artist has an individuality which is as clearly and distinctly marked as his hand-writing. A close inspection will furnish a most fascinating study, which will reveal much that has gone to make the reputation of the artist. Time spent in this manner will be most profitable to any one and especially to the students who are now engaged in drawing in its various departments.

THE new system of having absences excused, which is being given a trial, promises several advantages over the old method. Printed slips have been prepared which will be filled out and deposited in the box, placed for that purpose in the hall. These will be presented at the faculty meeting, where the merits of the excuse will be considered.

Formerly it was necessary to see Dr. Mees and give the reasons for absence. This method had several disadvantages, as it was often inconvenient to see Dr. Mees at the time, both on account of other duties and particularly as his time is so occupied with official business that he could not always be found at leisure when desired. With the new method there will be no reason for not attending to having the absences excused at once. This also promises to put a stop to unnecessary absences and trying to have them excused when there is really only a half-way reason. The number of absences in the last few weeks has necessitated some radical change, and the faculty hope that the troublesome problem has at last been solved.

With the work that is carried in each course it becomes absolutely necessary that close attendance be observed. Each day's work is dependent on that of the day before, and every recitation lost, adds so much more work that has to be done by the individual in order to keep up with his class. The few restrictions placed on the students are for their own good and should be appreciated in the manner in which intended.

PROFESSOR HATHAWAY attended the meeting of the American Mathematical Society in Evanston, and makes the following mention:

"The second meeting of the Chicago section of the American Mathematical Society was held in Evanston, Thursday and Friday, December 30th and 31st, in the hall of the North Western University. There were 20 papers upon the programme, embracing almost every topic in the higher mathematics. Rose was represented by a paper on "Alternate Processes" and a paper in connection with Prof. H. B. Newson of the University of Kansas, on "Continuous Groups of Spherical Transformations." One of the most interesting papers was the translation of a geometrical papyrus of the first century, with photographs of the original papyrus, by Prof. Goodspeed, of the University of Chicago. The contrast between the first and the nineteenth centuries was a noteworthy one. It appears that a figure with two sides parallel was then called a parallelogram. The meeting was an enthusiastic one and members were in attendance from the range of country extending from Ohio to Nebraska. A reception was given to the society on Friday evening by the President of the North Western University. One of the most important objects of the society is to afford these opportunities for the leading mathematical educators of the country to meet each other in social as well as intellectual intercourse. The members may know of one another through the work that each is doing, but added interest and mutual helpfulness is secured by learning to know one another through personal intercourse and knowledge of character."

THE thirteenth annual meeting of the Indiana Academy of Science was held Wednesday, and Thursday, December 29th and 30th in the State House, Indianapolis. The sessions of the Academy were largely attended and the meeting proved highly successful. The morning of the first day was devoted to the regular business and the election of officers for the ensuing year. That night the retiring President, Professor Thomas Gray, delivered an address on "The Development of Electrical Science," an abstract of which is given in this number of THE TECHNIC. The afternoons were devoted to the Sectional Meetings where eighty papers were read, covering a wide range of subjects. A partial list of the papers presented before the meetings is given, showing the scope of the work of the Academy:

Scovill, J. T — Lake Maxinkuckee Soundings.

Hessler, Robert — A New Laboratory and Its Work.

Dryer, C. R. — The Relation of Geology to Natural Science and Education.

Duff, A. W. — Decrease of Intensity of Shrill Sound with Time. The Constant Radiation of Air.

Foley, A. L. — Variations on the Spectrum of the Open and Closed Electric Arc. The Spectrum of Cyanogen.

Hathaway, A. S. — Alternate Processes.

Gray, Thomas — A new form of Galvanometer.

Noyes, W. A. — Camphoric Acid.

Coulter, Stanley — Contributions to the Flora of Indiana. Notes concerning the germination of composites.

Wright, J. S. — Notes on the Cypress Swamps of Knox county. Notes on crow roosts of Western Indiana and Eastern Illinois.

Eigenmann, C. H. — Origin of Cave Faune.

Culbertson, G. — Preliminary Work for the Approximate Determination of the Time since the retreat of the first great Ice Sheet.

Call, R. E. — Notes on the Geology of Mammoth Cave.

A Field Manual for Railroad Engineers, by J. C. Nagle, M. A., M. C. E., Professor of Civil Engineering in the Agricultural and Mechanical College of Texas. XV x 394 pages. XXVII Tables. 1897 John Wiley & Sons, New York. Price, $3.00.

THIS recent publication in a field already well filled, contains but little which may be called new. The following subjects are taken up in the order named below: Reconnoissance, Preliminary Surveys, Location, Transition Curves, Frogs and Switches, and Construction.

The chapter upon Location includes many problems which will be found quite convenient as suggestions for the young engineer.

It is to be regretted that the excellent chapter on Frogs and Switches does not present the latest practice, where the lead depends upon the length of switch-rail, and the length of the frog-wing which is straight. Since the standards for these distances differ upon different roads, a table of total leads could not be given which would be universal, but the general formulæ could have been presented and then the formulæ given in the book readily deduced from them.

One type of Transition Curve is thoroughly demonstrated and its application illustrated with many examples: — the subject covering thirty-two pages of text. Although the curve presented is very excellent, yet the compound transition appears to answer very well for practice, and has the advantage of being easily used without the introduction of a different process of computation from that with which the engineer is familiar in using simple circular curves.

Taking the book as a whole it is good. The subject matter is well arranged and the large number of tables makes it very convenient for student use.

A detailed Course of Qualitative Chemical Analysis of Inorganic Substances, with explanatory notes, by Arthur A. Noyes, Ph. D., Assistant Professor of Chemistry in the Massachusetts Institute of Technology. Third revised and enlarged Edition. The Macmillan Co., New York, 1897; 89 pages. Price $1.25.

ONE of the most distinctive features of this book is the omission of preliminary experiments, or "reactions," as an introduction to the work of analysis. It is the author's intention that the student shall begin with the analysis of a mixture of known substances and become acquainted with the conduct of each element by experience with the regular process of analysis rather than by a study of the conduct of each element by itself. His defense of this method is so excellent that it may be given. He says: "In reply to this objection, (that the student will acquire too narrow an acquaintance with chemical facts) and especially in the interest of a reform of what the author believes to be a vicious method of instruction, the following remarks may be added: In the first place, it should be borne in mind that the introduction of an excessive amount of material is a common defect in modern education, and that the number of chemical facts involved in the systematic scheme of analysis is as great as can be properly assimilated by the student in the time usually given to the course. Secondly, it is to be considered that qualitative analysis is a satisfactory method of teaching a part of descriptive chemistry chiefly because it unites into a connected whole a great variety of isolated facts, and because it makes evident to the student a practical use of the information presented to him; but these advantages evidently do not apply to facts not directly related to the process of analysis. And thirdly, the additional knowledge which it is most desirable that the general student of descriptive chemistry should acquire when time permits, is not a more extended acquaintance with mathematical test-tube reactions, which involve for the most part merely questions of solubility, but rather a knowledge of new principles and new methods of manipulation—information that would be much better given by a course in inorganic preparations.''

The scheme of analysis is given in the form of carefully detailed directions, followed after each paragraph by a series of notes explaining the process, pointing out sources of error and giving directions for modifications desirable in certain cases. The analytical process given is essentially that of Fresenius and the directions for procedure and notes are clear and excellent. The book gives evidence that the author has had a good deal of experience in teaching the subject, and it is very carefully worked out in detail. The writer prefers different methods of separation in a few cases, but those which are given are accurate and there is very little in the book to criticise.

The Development of Electrical Science.

By Thomas Gray.

ABSTRACT OF PRESIDENT'S ADDRESS TO THE INDIANA ACADEMY OF SCIENCE.

THE larger part of this address was devoted to the development of electrical science during the 17th, 18th and first half of the 19th century. The various important discoveries in electrostatics, in magnetism and in voltaic electricity, were referred to and their effect in the science discussed.

Of the practical developments the first referred to at length was telegraphy. The effect of the growth of the electric telegraph on the science of electricity was pointed out and the gradual evolution of our present system of measurements described. The following reference was made to the development of dynamo machinery and of electro-chemistry.

Magneto-electric and dynamo-electric generators and motors have now become so common that we are apt to forget that their introduction on an extensive scale has only taken a few years. Faraday's disc dynamo was, as has already been stated, produced in 1831, and a machine for generating electricity was made by Pixü in the following year. Pixü's machine consisted of a horse shoe permanent magnet which was rotated in such a way that its poles passed alternately in front of the poles of a similar electro-magnet. An alternating current was thus induced in the circuit which included the coils of the electro-magnet.

This machine was improved by Clarke, who revolved the coils and put a commutator on the axis. Other machines were made or suggested by various physicists and an important observation, which has since been frequently overlooked, was made at this time by Jacobi, who pointed out the importance of making the cores of the coils short. Sturgeon, in 1835, made a dynamo with a shuttle shaped armature, a similar form has long been identified with the name of Siemens. Woolrich made a multipolar magneto machine in 1841 for electroplating and Wheatstone about this time produced his small multipolar magneto, long used for telegraph purposes. In 1845 Wheatstone and Cooke patented the use of electro-magnets in place of the permanent magnets and Brett suggested, in 1848, that the current from the machine might be made to pass round a coil surrounding the magnet and thus increase its strength. A similar suggestion was independently made in 1851 by Sinsteden. In 1849 Pulvermacher proposed the use of thin laminæ of iron for the cores of the magnet, a proposition which has since, but probably for a different reason, been almost universally adopted. Sinsteden used iron wire cores and made a number of experiments on the effect of varying the pole face. About this time another class of machines were proposed by Ritchie, Page and Dujardin. In these machines both the magnets and the coils were to be stationary, but the magnetism was to be varied by revolving soft iron pieces in front of the poles. Modern representatives of these machines are to be found in the dynamos of Kingdon, Stanley and others. All the machines up to this time had been of very small dimensions. In 1849 Nollet began the construction of a alternating machine on a larger scale, but died before it was completed. Machines of Nollet's type were afterwards made by Holmes and by the Compagine l' Alliance of Paris; the latter being called the Alliance machine. These machines were used for lighthouse purposes. Holmes' earlier machines were continuous current, but later he left out the commutator and still later again introduced it on part of the coils for the purpose of obtaining current to excite his field magnets. This latter plan was introduced after the self-exciting principle had been described by Siemens and by Wheatstone. A remarkable machine, historically, was patented in 1848 by Hjorth. In this machine a combination of the permanent and electro-magnet was used. The first was to give magnetism enough to produce a current with which to excite the other. A similar idea was developed fifteen years later by Wilde with this difference, that the permanent magnet part was a separate machine. The idea of using part of the current from the armature to excite, or partially excite, the field magnets was, at this time, in the minds of a number of workers, and some remarkable machines were patented by the Varley brothers, one of which containing both a shunt and a series winding has been held by some to anticipate the compound winding now in use. In 1867 it seems to have occurred independently to Wheatstone and to Werner Siemens that the permanent magnet part of the Hjorth and Wilde machines might be dispensed with, the residual magnetism being used to start the action. Siemens gave the name dynamo electric machine to this type and it has stuck. In order to diminish the fluctuations in the strength of the current during one revolution of the armature, Pacinotti devised his multi-governed armature machine in 1864. This machine did not receive the notice it deserved for a number of years, and in the meantime Gramme produced his smooth ring armature in 1870. Gramme's machine was soon recognized as being of great merit and its gradual introduction gave rise to increased activity. In 1873 the Hefner Alteneck improvements on the Siemens armature were introduced and in the remaining 70's quite a number of forms of dynamo were invented. The Lontin type introduced in 1875, with improvement in subsequent years, being one of the best. The early 80's saw tremendous activity, the patent offices in Europe and America were flooded with inventions of various types of dynamos and motors, of lamps for electric lighting, and so forth.

It is curious how few of those machines have stood the test of time and how well the old types of Pacinotti, Gramme, Siemens-Alteneck and Lontin in some one of their modifications hold the field. Great progress has been made in the last fifteen years. Machines have assumed enormous proportions and the number of branches of industry to which they have been applied is now very large. Much has been learned during this time, particularly with regard to alternating currents and their application to the transmission of power. The introduction of multiphase systems being of considerable importance in this connection. In the direction of high potential and great frequency the work of E. Thomson and of Tesla is of great interest.

Of the application of electricity to the production of light and heat, little need be said in this connection. The difficulties to be overcome were largely mechanical and with the progress made we are all familiar.

As regards primary batteries there has been, of course, as we all know, considerable progress since the time of Volta. The number of forms brought into use has been enormous and they have been important in increasing our knowledge of the relative electro-motive force of various combinations and in their bearing on chemical knowledge. It can hardly be said that an ideal primary battery has yet been obtained, when we look at the subject from a commercial point of view. Although the subject is not very much to the front at present, however, it is destined to come again and will, I have no doubt be, in a comparatively short time, one of our leading industries.

The work of Planté and of Faure and others on secondary batteries has been of great value commercially. They gave rise to several chemical problems, but the main difficulties here also has been of a mechanical kind and they have not added much to the knowledge of electrical laws.

The transformation of alternating current from high to low potential, and vice versa, by means of what are commonly called transformers, has shown another remarkable development of Faraday's discovery of induced currents. The application of transformers has made it possible to distribute electrical energy over large areas in a moderately economical manner, and incidentally has led to considerable increase in the knowledge of the magnetic properties of iron.

One of the most important of the applications of electricity is that of electro-chemistry. The chemical action of the electric spark was noticed by Van Troest and Dieman in 1739 in the decomposition of water. Beccari, about the middle of the 18th century, obtained metals from oxides through which the spark had passed, and in 1778 Priestley noted the production of an acid gas when the electric spark was passed through air. Similar experiments were made by Cavendish, and Van Marum decomposed ammonia. It is not, however, till after the discovery of the voltaic cell that the subject of electrolysis really begins. I have already referred to the discovery of Nicholson and Carlisle in 1800, and the subsequent work of Davy and of Faraday. The peculiar phenomenon of the appearance of separated elements only at the end plates in the electrolytic cell, led to considerable speculation, and was explained by Grothuss on the supposition that the molecules separated into two parts, one positively and the other negatively electrified, and that these parts formed a chain between the plates along which chemical action traveled by a continual interchange of mates, the end parts going to the plates. This theory was held for many years and is still to be found in some text books. Faraday's work is by far the most valuable of the early contributions to this subject. He gave the following laws:

The amount of chemical decomposition in electrolysis is proportional to the current and the time of its action.

The mass of an ion liberated by a definite quantity of electricity is directly proportional to its chemical equivalent weight.

The quantity of electricity which is required to decompose a certain amount of an electrolyte is equal to the quantity which would be produced by recombining the separated ions in a battery.

These laws are all of the greatest importance, and the last one clearly points out the reversibility of the electrical process. By forcing a current through an electrolyte it is decomposed and the mutual potential energy of the components consequently increased. By allowing the components to recombine in a battery the mutual potential energy is reduced and a current of electricity is the result. An excellent illustration of this action is exhibited by the secondary battery.

In 1857 Clausius gave a theory of electrolysis and at the same time reviewed the weaknesses of the hypotheses of Grothuss and others. Clausius assumes that the molecules of the liquid are in continual motion, that impacts frequently occur which produce temporary dissociation, leaving atomic groups charged with opposite electricities, and that during these separations any directive agency, such as an e. m. f., is able to cause a motion of these atoms in opposite directions. This is probably the first indication of the idea of the purely directive character of the applied electro-motive force taking advantage of dissociation to produce chemical separation.

The energy side of the problem now began to attract attention, and the development of what may be called the thermodynamics of electro-chemistry began. Among the most prominent workers in this field have been Joule, Helmholtz, Gibbs, Kelvin, Boscha and Favre.

In 1853 Hittorf made quantitative determination of the change in concentration near the electrodes when a current is passed through a solution. This work is of historical interest because it formed practically the starting point for what may be called the modern view of electrolysis. Hittorf's experiments extended over several years and served practically to establish the theory of the migration of the ions in the solution. Hittorf enunciated the following laws:

The change in concentration due to current is determined by the motion which the ions have in the unchnaged solution.

The unlike ions must have different velocities to produce such change of concentration. The numbers which express ionic velocities mean the relative distance through which the ions move between the salt molecules, or express their relative velocities in reference to the solution, the change in concentration being a function of the relative ionic velocities.

Hittorf's analysis enabled him to give numerical values to these relative velocities. The experiments of Nernst, Loeb and others have extended Hittorf's results, and have shown that in dilute solutions the relative velocities of the ions are independent of the difference of potential between the electrodes, and are only slightly if at all influenced by temperature. Hittorf pointed out that a knowledge of the conductivity of electrolytes should give valuable information in reference to the nature of electrolytic action. A great deal of work has been done in this direction, by Horsford, Wiedeman, Beets, the Kohlrausches and others. The most notable perhaps was the work of P. Kohlrausch who devised a method of measurement using alternating current by which results of high accuracy were obtained. Kohlrausch's results give the sum of the ionic velocities, and thus combined with the results of Hittorf on change of concentration, which gave the ratios, the absolute velocity can be obtained. It appears from these results that the velocity of the ion in very dilute solutions depends only on its own nature and not upon the nature of the other ions with which it may be associated. For example the velocity of the chlorine ion is the same when determined from solutions of KCl, $NaCl$ or HCl. The important general law has also been found that the conductivities of neutral salts are additively made up of two values. One dependent on the positive the other upon the negative ion. If then the velocities of the ions themselves be known the conductivity of a salt may be calculated. The results of Kohlrausch received strong confirmation from some very ingenious experiments by Lodge and Wetham in which the migration of the ions was made to produce a change of colour in the solution and would thus be directly observed.

In 1887 the theory was advanced by Arrhenius and Ostwald, that dissociation is directly effected by solution or fusion and that in very dilute solutions the dissociation is practically complete. Arrhenius holds that the ions carry charges of electricity positive or negative dependent upon their nature, but of equal quantity in every ion. The remaining part of the theory is similar to that of Clausius and others. According to this theory, the ratio of electric conductivities for different densities of solution gives a measure of the relative dissociation or ionization. If the act of solution effects the dissociation necessary to admit of electrolysis, chemically pure substances ought not to be decomposed by the electric current and this is found to be the case. It is curious that two substances like hydrochloric acid and water, which separated are insulators should, when mixed, conduct readily and that practically only one of them should be decomposed. This however is only one of the many problems still to be solved. Another question is, how do the ions obtain their electric charge? Still another, what is the nature of the force which causes ionization? There are many more.

When we turn to the commercial application of electro-chemistry we are met with astonishing evidence of activity. Only twenty years ago there was comparatively little evidence of the importance of this branch of applied electricity. At the electrical exhibition in 1881 electro-chemistry was apparently of comparatively little prominence. A factory which could annually produce a few hundreds of tons of copper electrolytically was considered a wonder. The production of thousands of tons a month is beginning to be looked upon as commonplace. There is scarcely a metal which cannot be deposited electrolytically with comparative ease and the prices of some of the rarer metals is going down rapidly. Zinc used to be considered a difficult metal to deposit successfully. It is now produced in some of the Australian mines in almost a pure state from refractory ores at the rate of thousands of tons per annum. Similarly the old method of galvanizing is rapidly disappearing and electro-deposition is taking its place and this metal is now so deposited on the hulls of ships, on anchors and other smaller articles cheaply and perfectly. A new industry has practically sprung up and there is every indication that the technical chemist of the near future will have to take an inferior place unless he be also well versed in electrical appliances. This branch of applied science is revolutionizing many things. It has within a few years produced an enormous improvement in our magazine illustrations and has at the same time reduced the cost of this kind of literature and of atlases and charts enormously. Electro-chemistry is now used on a large scale for the production of chlorate of potash, bleaching materials, alkalies, coloring matters, antiseptics like iodofom, anesthetics like chloroform, etc., in fact it is getting to be difficult even to enumerate the manufactures in which it is used. It has revolutionized the extraction of gold, and plants of enormous capacity are now in use in some of the gold fields the poorest ores and tailings being made to yield up almost the last trace of the precious metal. The production of ozone by the ton, the purification of sewage, the sterilization of water are all accomplished facts.

Some progress has even been made in the introduction of chemicals through animal tissue by electrolysis or cataphoresis and Röntgen has shown us how to see through the body.

Then again we have the electric furnace and with it the power to fuse almost the most refractory substances. In this way aluminum is now produced at a few cents a pound whereas most of us can remember when its price had to be reckoned in hundreds of dollars. In a similar way phosphorous is now produced on a large scale as are also various carbides, carborundum, acetylene, etc.

It is impossible to look back over the history of electricity and its applications, and notice the apparent geometric ratio in which advances are being made, and not to speculate on what a giant this science is going to become in another quarter of a century. Undoubtedly no one can study this one branch of science without being persuaded of the great value of scientific work for the advancement of human enterprise.

Notes on Lead-Silver Mines ... and Smelting Works.

By Max B. Fitch, '90, Supt. Graphic Smelting Works.

THE MINES.

THE Graphic Group of Mining Claims is located on the west slope of the Magdalena Range of mountains in Socorro County, New Mexico. Mines on these claims lie about three miles southeast of Magdalena, the shipping station on a branch of the Santa Fe Ry., and about one mile north of Kelly, the mining camp brought into existence by the proximity of these and other mines.

The entrance to the mines is about seventy-five hundred feet above sea level and about nine hundred feet above the station at Magdalena.

The Geological formation in which these mines occur is the Sub-Carboniferous. In the uplifting of the mountain range, the strata was tilted to an average inclination of about forty-five degrees, and by the heat attending that movement, the sandstones were metamorphosed into quartzites and the purer limestones into marble.

The two principal veins of the Graphic Mines occur within a zone or belt of limestone and the greatest thickness of this zone, measured perpendicular to the strata, is only about one hundred feet.

It is perhaps proper to remark, that what follows may not be strictly orthodox for the genesis of lead ores, but it is the way things look in these mines. It appears that when the rocks were uplifted, this limestone belt was split along the bedding planes of the strata in two places about forty feet apart, and that sliding occurred along these splits, and that when the rock masses came to rest, there were misfits along the bedding planes forming cavities sometimes hundreds of feet in length and from nothing to many feet in width. Water circulating through the cavities enlarged some of them, and finally filled nearly all of them with some kind of material, either of earth, or rock, or ores, separately, or, as frequently happens, of mixtures of all of them. The valuable ores are generally mixtures of iron, silica, lead, zinc, copper, lime, silver and a trace of gold, the proportions being in the order named.

It appears that the iron, lead, zinc and copper were originally deposited as Sulphides, and that afterwards, where the ground was open and the conditions were favorable, they were changed by oxidation, making what is called "Carbonate Ores." In some places where the veins were enclosed by solid rock, the iron is partially oxidized and the lead and zinc are unchanged, while in other more open places, the whole mass is oxidized, except some nuggets and boulders of ore that are still sulphides at the core, while the outside is carbonate and the intermediate sulphate, showing very well the progress and order of oxidation.

It follows that in the product of these mines, a great variety of ores occur. Of iron, there is pyrites, magnetite, red and brown hematite; of lead, there is sulphide, sulphate and carbonate. These forms occur in all degrees of fineness, from massive solid mineral to dust as fine as flour.

The ores generally consist of a more or less intimate mixture of these minerals and various forms of silica, though there is one observed combination. It is a hydrous carbonate of zinc and copper, called Aurichalcite.

With the oxidation of the ore masses, there appears to have been some segregation of the iron, lead and zinc, by the formation of nearly pure iron ore (58 to 62% Fe.) in some places and of lead ores in others, while the greater part of the zinc that was retained formed in crusts along the foot-walls. Some of the zinc must have been carried away, for it is in decidedly less quantity in the oxidized than the un-oxidized ores. The indications are that these mines have been a most wonderful laboratory of Nature.

The method of working these mines is by tunnels driven along each of the veins at different levels, and stoping out the ore by working upward from one level to the next one above.

The tunnels are connected by cross-outs at intervals, and at the north end, those below the entrance level, connect with an incline, up which the loaded ores are hauled to the entrance level, and from thence they are run outside to the bins for ore and to the dump for waste material. The main entrance to the mines is on the north end of the property, where a gulch gives ample room for bins and dumping grounds.

Limited within one hundred feet of thickness of limestone which is bounded on one side by shale and on the other by quartzite and with the enclosed veins occupying certain bedding plane of the inclined strata, this would be a tolerably simple mining proposition, except for two series of faults in the strata which complicate matters considerably.

The course or strike of the first series is nearly perpendicular to the axis of the mountain range, and they dip steeply to the south. One of these faults is near the north end of the Graphic properties. The strata north of this fault are thrown down the mountain side about one hundred and fifty feet. The veins south of the fault and the fault fissure itself are mineralized, but the continuation of the veins north of this fault has never been found. The rock thrown down the mountain sides has thus completely masked the ends of the veins that would otherwise show in the gulch, and the entrance tunnel is driven through barren rock to reach them. The second fault of this series is about one thousand feet south of the first one, and has a somewhat greater throw in the same direction.

In the second series, the fault planes are nearly horizontal, and the strata below each fault are thrown outward to the west. One of these has been investigated and the throw found to be about fifty feet. Another, two hundred and fifty feet above it, is being worked out now, and its throw will be more than twice as great. How much more cannot be told except by the slow process of digging it out through solid rock, for the surface of the mountain side is so covered by debris that these faults cannot be traced upon it. These fault planes are only mineralized in places, but there is always mineral crossing them somewhere, connecting the veins above with the veins below.

When the problems are once worked out, they seem simple enough, but while the work is going on, there are plenty of opportunities for the exercise of experience, skill and good judgment.

THE TRAMWAY.

The Tramway from the mines to the smelting works in the valley below, is seven thousand feet long, and falls in that distance six hundred feet; more than four-fifths of this fall being in the first five thousand feet on the mountain side, after leaving the mines. At the upper end, the line is somewhat developed or made longer to accomplish easier grades. The shortest radius of curvature is fifty feet and the maximum gradient is twelve and one-half per cent., a fall of one foot in eight feet. The road is three feet gauge, laid with steel rails, twelve pounds to the yard, on sawed native pine cross-ties, four by six inches and five and one-third feet long.

In locating the line, considerable pains was taken to get it in the sunshine, and this was accomplished on all but about three hundred feet at the upper end. This is really a matter of considerable importance, for with such steep grades it is absolutely essential to have a clean, dry rail, and though this is an arid climate, there are sometimes short heavy rainfalls in the summer, and moderate falls of snow in the winter. In the summer, a few minutes of sunshine will dry the rails, so the interruption to traffic is but little longer than the time the rain is falling. Even in the winter, the sunshine is quite warm, melting the snow quite rapidly, a considerable portion being evaporated, and the remainder being taken up by the dry earth where it falls.

Last winter, after a fall of six inches of snow over night, a rough snow plough was made in the morning, of two planks spiked together like a letter A and this was drawn down once over the road. By noon, the sun had done the rest and the road was operated in the afternoon. A fact well known to railroad engineers, that the writer learned by experience, is that a coating of rust on the rails is almost equivalent to putting on so much grease.

The tramway is operated by hauling the empty cars up to the mine with horses, one horse to each car. The cars are there examined, all the wheels taken off and the axles coated with axle-grease; the cars are then dropped down to the chutes under the three hundred ton ore bins, and are there loaded with ore drawn from the bin, each car holding from two and one-half to three tons, according to the richness of the ore. After being loaded, they are run on to a siding and coupled together, nine cars in a train. Two men and a boy having arrived with a train of empty cars, they unhitch the horses and turn them over to the boy to drive down, while the two men take charge of the loaded train and run it down, controlling it altogether with hand-brakes, setting the brakes down hard on the steep grades and gradually letting them off where the grades are lighter. The trip down is made in twelve minutes and though the speed is slow, the ride is properly described as "exhilarating."

To control loaded cars by hand-brakes alone, down such steep grades is somewhat unique. If it is accomplished anywhere else, it is unknown to the writer. It was accomplished here only after careful experimenting and much study of the problem. That it was successfully accomplished in this case is largely due to the skill and persistence of Mr. Geo. A. Byron, the superintendent of mines, who besides being a very capable man, is something of a mechanic as well.

In the experiments, it was found that a large momentum factor was a very difficult thing to get under control, so the speed was limited to making the trip in twelve minutes, at which speed the trip is as "safe as a church." At first the trips were made with two, then with four, then with six cars in a train, but it was found that a larger number of cars in a train worked better, because then, the letting of the brakes off one car, while perhaps enough to keep the train running, would result in a smaller percentage or the brake power being released, and therefore less danger of the train getting out from under control. The subject of car-brakes was a serious matter. On their efficiency depended the success of operating the tramway. Naturally they went through considerable evolution before the present system was arrived at.

The car-wheels are sixteen inches in diameter and are made of cast iron, with a chilled tread three inches wide. The axles are spaced twenty-two inches apart and are clamped and bolted directly to the car-body. The wheels turn freely on the axles and are held on by a linch-pin.

The brake shoes or blocks are cut out of native pine planks three inches in thickness, and shaped so that when they are applied, each shoe fits between the pair of wheels on one side of a car and covers nearly one-fourth of the circumference of each wheel.

The brake frame consists of an oak lever, three by five inches in size, on each side of the car, one end hinged to the front end of the car body and the other end extending about six inches behind the car body, where the two are bolted to a cross piece. A screw brake staff in the center of the rear end of the car raises or lowers the brake frame and holds it secure. The brake shoes are hinged to and underneath the levers of this frame, so that they can be turned out and upward in order to permit the wheels being taken off to be examined and the axles greased. When a brake shoe is turned down it is held in place by two iron latches. One end of the latch is bolted to the brake lever, and the other is turned down alongside the brake shoe to keep it from sliding outward when pressed down on the wheel.

The screw brake frame applies the brakes on both sides of the car simultaneously and holds them where they are set until they are released, so that one man traveling over the top of the train can manage the brakes on a number of cars.

This brake system has been found to work admirably, and is amply sufficient to control loaded cars running down the steep grades above indicated, provided the momentum factor is kept within proper bounds. This is usually accomplished by not allowing the trains to "get a start." If, for any reason, the train should start to run away, one-half the cars are provided with "emergency brakes." These are simply heavy iron sled runners about twelve inches long, that are thrown down on the rails behind the rear wheels, and by means of levers nearly half the weight of the car and its load can be placed on them. They are rarely brought into use except in bad weather.

In the beginning self-oiling wheels were used on the cars, but on account of imperfect lubrication and the cutting of both wheels and axles by the fine ore dust, it was found better in practice to take off all the wheels each trip, to observe their condition and see that they are properly lubricated, and common axle-grease was found to be the best lubricant. In good weather six round trips are made each day. The average, for a year, has been over three thousand tons a month, and the cost of loading from bins, hauling, weighing, dumping and maintenance of track, bridges and cars, is less than twenty cents a ton of ore delivered.

[CONTINUED NEXT MONTH.]

Alumni Editor of Technic:

Being in a rather isolated place to spend our Xmas, with nothing to do but smoke, I tried to break the monotony by writing some of our experiences for THE TECHNIC.

Seeing an article in Rose Leaves by a member of the class of '99, telling the trials and pleasures connected with the "Civil's Trip," reminded me of the fact that the experiences encountered in actual practice might be of interest to a few.

Ordinarily, I would never worry my brains over this writing, but under the conditions we are in to-day, it will relieve the monotony somewhat.

When tents were pitched at this camp we were in a locality of poor drainage, which turned out to-day to be a very serious matter. It started to rain last night just after we had gone to bed, about 8 P. M. This morning, when awakened, we heard the rain still coming down in torrents, and saw that the office tent, which was on lower ground, had about six inches of water in it. After donning our rubber boots and stepping outside, we had the pleasure of seeing a small lake all around us. I might say just here that when retiring we take off only our hats, coats and boots; hence we are always ready for emergencies. A very fortunate thing for us happened in that the "Chuck-a-way Chief's" tent (or, in plain words, the cook's tent) was on high ground.

After breakfast, all hands were called to man the pumps, or rather spades, and a 500 ft. ditch with a network of drainage was dug to carry off the water. It is slowly receding, and will be noon before the place is thoroughly drained.

Our corps comprises fifteen men. We have a dining tent, one large tent for the boys, or the "terriers," as the chief calls them, and two more tents swung into one, for office headquarters. The office proper is for the draftsman, containing his table, stationery box, and all the instruments. The other tent is the sleeping apartment, and holds five cots for the chief, transitman, levelman, draftsman and assistant. The boys' tent is filled by the transit-bearer, rodman, head chain, rear chain, back flag, stake man, axman, cook, commissary and teamster. Each man is furnished with a wire cot, (quite a luxury) a mattress, a double blanket and one comforter. Each tent has a wood stove, and they are kept red-hot at the expense of the nearest patch of timber. The kitchen is not furnished with Haviland China ware, but with granite stone ware. Our table spreads are oilcloth, and knives and forks of the best steel. Our rocking chairs are empty soap boxes, and the wardrobes—well, you usually find all the clothes a man owns on his back. The food is wholesome, and plenty of it. Army beans, pork, potatoes, bread and coffee. If the cook, however, has to kill a few chickens that come into camp, in self defense, we have a feast. This happens very seldom—usually when the chief is away on business.

Our hours are very easily remembered. First call at 5 A. M., breakfast at 5:30 and all hands in the line-wagon at 6 o'clock. Lunch is eaten at 11:30. The teamster builds a large fire, heats the coffee, empties the lunch box of its bread, sorghum, beans and pork, and all hands enjoy, yes, I mean enjoy, the meal. A half hour respite is given and the work starts again.

We have an ordinance for all lights to be out at 9 P. M. It is unnecessary however, for 8 P. M. generally finds everybody in bed. On rainy days it is different. The office force look after their notes while the "terriers" make up stakes and replenish the woodpile. Then the cards come out—Whist, Cribbage, Pedro and Seven-up reign until bedtime.

We have a native axman who is death on "them there gambling games." Gambling, however, is not permitted under penalty of losing your job. This same axman is as green a man as one runs across nowadays. We picked him up at one of our camps—he never saw a railroad nor had he ever been in a city of any size. Of course the boys have a good deal of fun at his expense, but a better workman could not be had. Trees, brush and brier, all disappear when he gets started. Before taking this job he was getting $12.00 a month and "find;" his $25.00 at the first pay day looked like a fortune, I guess. There was a new corduroy suit, a "bile" collar and shirt for extra, cap, boots, etc. He is learning fast, however. Has already applied to the chief for sleeping quarters in the office tent on account of theirs being so crowded. Our method of work is very simple. One or more preliminary lines are run, depending entirely on the kind of country; levels taken, the topographer making a scale sketch of the drainage, roads, creeks, property lines, houses, barns, timber, grain, etc. After an average of about 12 miles have been gone over, the location is laid on the map and then run. All tangents are run to an intersection, angles measured, the curve staked, and levels taken on it instead of on the tangent as is sometimes done. The topographer ties in to all section corners where possible and in addition to his usual work on preliminary lines gets the names of all property owners. After location comes the hard work, that of moving. It takes three large army wagons to carry the outfit, with the corps walking. Four A. M. is the first call on that day and by the time tents are pitched all are willing to eat their bite of supper and go to bed.

Although the work is enough to try any man's grit there are many enjoyable and laughable incidents to break the monotony. We sometimes run across very odd natives along the line, agricultural gentlemen or better known as farmers. One of them asked the rodman why the figures were "much morely worn out" at the four foot mark and was informed that the levelman looked at that part of the rod oftener. Another incident with an ignorant, superstitious darkey, who wanted to know what it was that made those bubbles tell when that there three legged thing was level. He was informed—

spirits—but mistook the meaning and always kept some distance from the transit.

I might add in conclusion that the sooner a C. E. gets on an Engineering corps in the field, the sooner will he appreciate the usual commodities offered to him. "ONE OF '96."

Jasper, Dubois Co., Dec. 25, 97.

ALUMNI NOTES.

B. F. Chandler, '97 is located at Guilford, Vt.

W. G. Arn, '97 is at present in Scottsboro, Ala.

W. A. Layman, '92 has been chosen Alumni orator for '98.

Fry, '97, is electrician for the C. H. & D. and is located at Lima, O.

Ingle, '97, is with the Oakland City Coal Mines, Oakland, City, Ind.

W. H. Palmer, '87, is with the Edison Illuminating Co., St. Louis, Mo.

Wm. H. Waite, '93, is with the Vulcan Iron Works Co., at Toledo, Ohio.

W. E. Becker '93, is with the Connersville Blower Co., Connersville, Ind.

Edward C. Elder, '86, was visiting his friends in Terre Haute during the Holidays.

T. W. Ross, '93, has for his present address W. S. C. R. "Perry" Astoria, Oregon.

W. J. Klinger, '96, is in the Electrical Department of the Barney & Smith Car Works, Dayton, Ohio.

Holdeman, 97, is at present superintendent of the Hutsonville Brick & Tile Co., of Hutsonville, Illinois.

THE TECHNIC has received several rumors of the approaching marriage of Hedden, '94. We extend our best wishes.

THE TECHNIC extends its most hearty congratulation to Mr. and Mrs. W. E. Burk upon the birth of a son, William Martin, on Jan. 12.

J. J. Kessler, Jr., '97, has accepted a position with the General Electric Co., Schenectady, N. Y., and will be in the Physical Testing Laboratory.

Hall, Fry, Heichert, Ingle, Shaver, of the class of '97 visited Terre Haute during the vacation and were most cordially welcomed by their many friends.

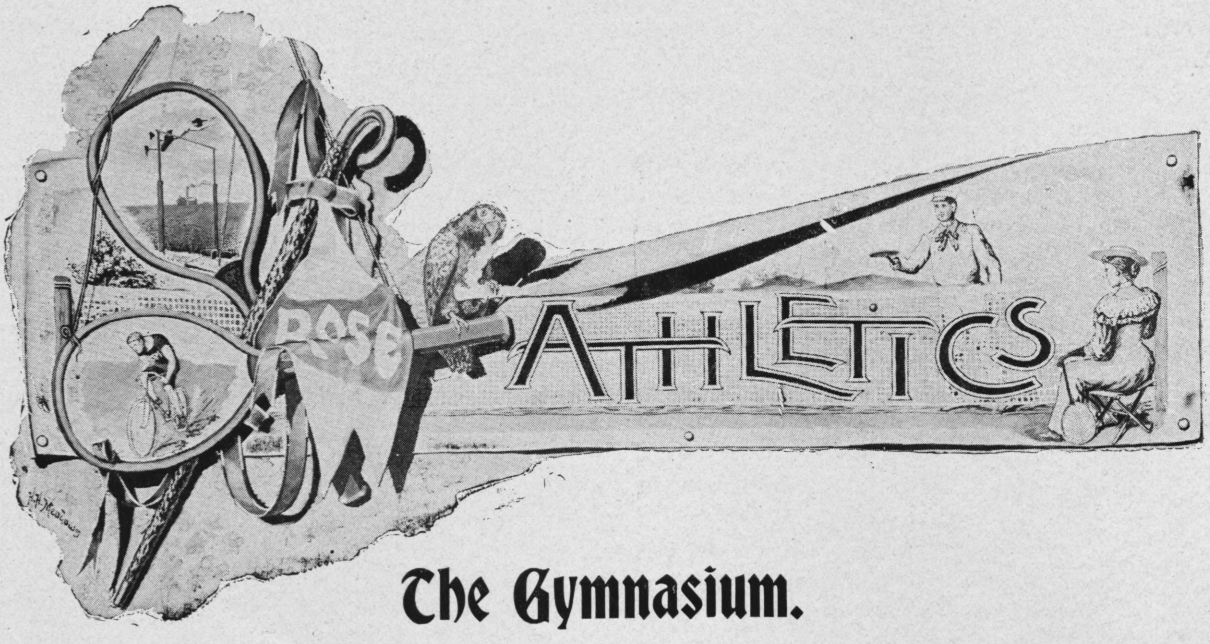
B. R. Putnam, '92, has left the Union Colliery Co., to accept the position of chemist with The Montana Ore Purchasing Co. His address is 306 West Broadway, Butte, Mont.

Mr. E. P. Decker, ex-'90, has resigned his position as Chief Engineer of Building for the New York Telephone Co., to accept the position of First Assistant Engineer of the Sprague Electric Co. at 20 Broad St., New York.

Edwin S. Johonnott, '93, is a Graduate Student at the Chicago University. He holds a senior fellowship and expects to receive in the near future the degree Ph. D. His city address is 5628 Ellis Ave.

H. M. Stanton, '94, and Miss Josephine Pierce Izer were married December the 28th in Chicago. THE TECHNIC extends its best wishes and congratulations. Mr. and Mrs. Stanton will be at home to their friends after March the first, at 1528 Garfield Place, Indianapolis, Ind.

S. D. Collett, '90, Engineer in charge of the Interior Block Department of the New York Telephone Co., has resigned to accept the position of Eastern Manager of the Elevator Supply & Repair Co., of Chicago and New York, with office at 40 Cortlandt St., in the latter city. Arthur Rice, '93, was chosen to fill the vacancy made by the resignation of Mr. Collett.



The Gymnasium.

At last the long-looked-for lockers have been set up in the dressing room of the gymnasium and the greatest expectations were amply fulfilled, for the quality of the lockers is beyond doubt.

Now there can be no complaint made about inconveniences of having no place to keep the necessaries for exercise and it is expected that the gymnasium will soon be the most used building about the Institute.

All out-of-doors systematic exercise is impossible during the winter, and unless the men can find a place to exercise during that time Rose would make a poor showing on Field Day. Formerly the men were obliged to attend the city Y. M. C. A. gymnasium, and the athletic spirit was always so high that these classes were always well attended in spite of the great inconvenience of having to come out after supper two nights of the week. The men have always appreciated the fact that unless the physical condition is well kept up during the cold weather, it will be hard to do justice to themselves and to their school by a few weeks' exercising previous to the field day. There are few colleges that have taken more interest in athletics in the past than has Rose. In the year 1891 over 90% of the entire school were active members of the Athletic Association. They all went at it with the same aim, that of obtaining the pennant from the I. I. A. A., and as a result Rose came off victors for six successive meets. At the last two meets Rose was second, each time being beaten by a small margin. In base ball Rose has done some good work, getting the pennant in '91 and coming fifth in '92, fourth in '93 and second in '94, while since then no championship games have been played. In foot ball Rose deserves great credit, especially in her last year's showing.

All this success lay simply in the fact that there was earnestness and interest on the part of the individual; a set of foot ball enthusiasts will never let the inconvenience of the hour of practice be a hinderance to their work if they are made of the right stuff.

But now Rose is provided with the best college gymnasium in the state, well fitted out and equipped with apparatus that can be used by the individuals to train for any event on Field Day. Arrangements are made for pole vaulting, running the hurdles, putting the shot, high and broad jumping, and all manner of other sports which keep the muscles in good trim and the body active.

Come out, men, and take advantage of all these opportunities. If the pennant was won formerly under so many difficulties, it can certainly now be well fought for with the present array of men. Show your spirit, pay your Athletic Association dues, and not only benefit yourselves, but hold up the high standard set by your predecessors. In order to succeed there must be one undivided effort on the part of the students, such as was so marked in the former history of the Rose Tech.

BASKET BALL.

The basket ball season is now full at hand and interest in the game is rapidly increasing.

The teams, urged on by class rivalry, are all getting down to solid work and from the present prospects many exciting games may be looked for during the winter. It will be so arranged that each of the class teams will play four games and the championship will be determined by percentage. In case of a tie the two winning teams will play it off between them. The Freshmen being new to the game will play several games amongst themselves in order to be able to select a team that can represent their class.

Manager Pfleging has not as yet made any arrangements for outside games to be played by the school team but is waiting to see what material may be at hand from the developments of the class games. Arrangements will be made however to obtain games from the city Y. M. C. A., the Indiana State Normal and possibly from other colleges of the State.

The prospects for a good team at Rose is indeed bright for the material present is all that could be desired and it will only take a certain amount of practice to develop a team even stronger than that of last year.

Basket ball, although by no means as popular a game as foot ball or base ball, is perhaps the most suitable game by means of which the men can keep up their wind and muscle during the winter months. It is a game which demands all the power of wind and activity with which man is endowed; but if not carried too far it will do more toward making allround athletes than almost any other game.

JUNIOR--SOPHOMORE BASKET BALL GAME.

THE first basket ball game was played on Saturday, Jan. 8th, in the gymnasium between the teams of the '99 and '00 classes and resulted in a victory for '99 with a score of 11 to 6.

Both teams played with but little previous practice so that most of the gains were individual, but few passes being made at any point of the game. The ball was batted around considerably and an unnecessary amount of wild throwing was present. This however is to be expected at the first game under such conditions.

The '00 team was clearly outplayed throughout the game and succeeded in throwing but one goal from the field, whereas '99 succeeded in getting as many as 5 goals from the field.

There was no rough playing in the game and the number of fouls called on the men were comparatively few.

The results are as follows:

'00.

Players.	Goals. From Field	Goals. Foul	Fouls.
Pfleging	1	4	2
Maier	....	....	1
S. Kidder	....	....	2
Madison	....	....	....
Appleton	....	...	1

'99.

Players.	Goals. From Field	Goals. Foul	Fouls.
A. Kidder	1	....	2
Kittredge	1	....	....
Jumper	3	1	1
McLellan	....	....	1
Stone	....	....	3

Referee, McCormick; Umpire, McMeans.
Time Keeper, Shepard; Scorer, Crebs.
Score '99—11, '00—6.

MEETING OF ATHLETIC DIRECTORS.

A MEETING of the Athletic Directors was held in Dr. Mees' office Monday, Jan. 10. The meeting was called to discuss the arrangements to be made for Field Day. The annual meeting of the Indiana Association is to be held at Indianapolis on the same date as the oratorical contest and the instructions which should govern Rose Tech's delegate were discussed. It was decided to send Pres. Hubbell.

Mr. Howell then asked for permission to enter a schedule of base ball games with the other colleges in the state, and as a meeting was to be held at Indianapolis, probably at the same time as the Association meeting, he desired some plan approved by which such a schedule might include Rose Tech.

It was decided that if the base ball meeting was held on the same day as the Association meeting, that Mr. Hubbell should attend this meeting also, and enter into the schedule, otherwise Mr. Howell should attend the meeting of base ball managers and arrange the schedule himself.

Dr. Mees then brought up the subject of gymnasium lockers, and suggested that the cost of lockers be twenty-five cents a term to members of the Athletic Association and one dollar a term to others, excepting, of course, those belonging to gymnasium classes, who should be supplied with lockers without additional cost.

The meeting then adjourned until Friday, Jan. 21st, on which date a foot ball manager for 1898 is to be elected.

NOTES.

The hand ball court is being well used at present and much interest is being manifested in the game. No tournaments have as yet been held, but Professor Hathaway and Instructor McMeans now have the subject under consideration and a schedule will be arranged. The games, both doubles and singles, will be played between the different classes and will begin in a very short time, so that it is necessary that the men who intend to enter begin getting in practice.

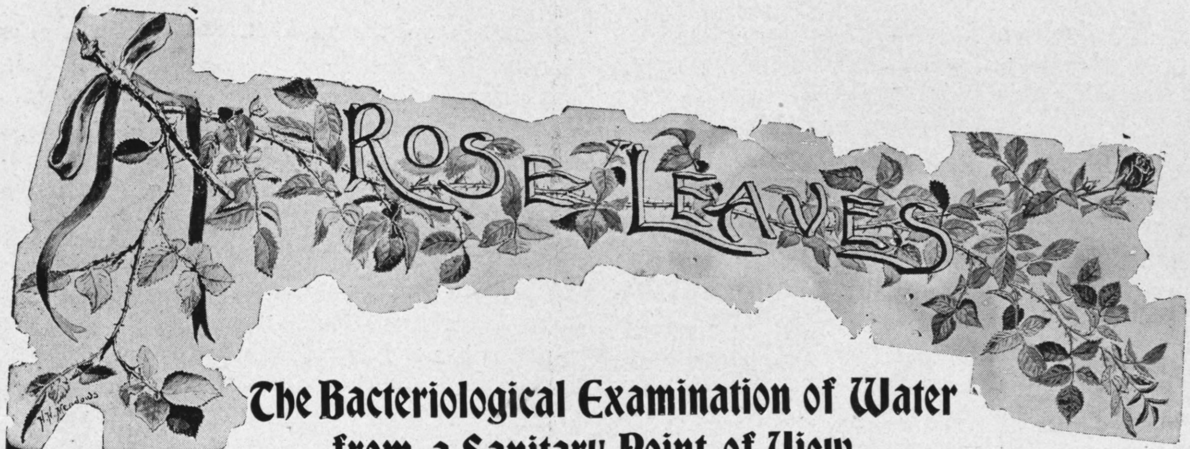
The gymnasium classes have not as yet started in spite of the fact that the lockers are now in their position, but Dr. Mees has stated that regular work will soon begin. The present delay is caused from the fact that no arrangements have been made for an instructor of the classes. This matter is now being considered and a selection will soon be made, so that the men of the two lower classes can prepare themselves to spend two hours each week throughout the present term in gymnasium work. This time will be extra and each man will be required to take this part of the course.

The two sections of the Freshmen class played basket ball on Saturday, Jan. 15th, in the gymnasium. The men were all new at the game and as a result a number of fouls were called. Some of the men, however, showed considerable skill in throwing goal from the field and with some practice '01 ought to be able to select a team that will be a credit to the class. The following are the teams:

SECTION A.	SECTION B.
Weatherhead, Capt.	Kittredge, Capt.
Hadley.	Crebs.
Hammel.	Stevens.
Lyon.	Wilbanks.
Shepherd.	Miller, Shaley.

Umpire, Pfleging. Referee, Jumper.

Score — A, 13 ; B, 6.



The Bacteriological Examination of Water from a Sanitary Point of View.

N. M. Austin, '98.

THE fact that bacteria are present in the water to a great number need not make the water unfit for drinking. Bacteria derived by the water from air and the ground are generally harmless. Those derived from pollution and sewage are the ones to be excluded from the system.

Until recently if a water was found to contain 250 bacteria to the cubic centimeter it was condemned. The method of examining the water was to mix with one c. c. of the water nine c. c. of sterile nutrient gelatine. The mixture was poured upon sterilized glass plates, where it solidified in a moderately thin layer. The plates were covered and examined again after three or four days by the microscope or the unaided eye, each bacteria having developed into a colony, and the colonies being counted and recorded.

In 1887 Mr. E. H. Dunham began a series of investigations. The water supply of a town near Boston was obtained from a number of driven wells, all of which excepting one, being connected by pipes to the pump which forced the water into the town reservoir. The other well was used for observational purposes on the level of the ground water, this well being kept covered.

The water taken from a tap at the pumping station showed 2 bacteria per c.c., while that from the isolated well showed 5,000 per c.c. The water running through the pipes was not exposed to the bacteria in the air, while the water in the single well was. These bacteria were all of the same species, and the water from the same source, thus leaving no doubt but that both waters were equally fit for drinking.

Plate cultures made from water known to have contained sewage, contain colonies of a yellowish or brownish color when viewed under a microscope. They are round, oval, or lunular in shape. They are probably what are called Colon Bacillus, indicating sewage in the water and should be avoided.

The principal thing of importance in examining a water as to its fitness for drinking, is to determine if it contains or is likely to contain poisonous substances, or the contagia of disease. The mineral poisons are determined by Chemical Analysis, and the disease bacteria by Bacteriological Methods.

Sewage bacteria are derived from intestinal tract and putrefactive substances, thriving in solutions rich in organic matter.

A bacteriological examination of water which would undertake to isolate and determine how each species gained access to the water would be very exhaustive, and also quite beyond the scope of the present knowledge of the subject. A few simple procedures are used to give information of the bacterial history of the water and upon which is based the judgment of the sanitary value of the water. Two questions are to be answered in accomplishing this end: (1) Whether the water has been polluted with sewage; (2) In case there are many bacteria present, their probable origin.

Most bacteria found in air are aerobes and incapable of growth excepting in the presence of oxygen. This fact is of advantage in obtaining a rough estimate of the number of bacteria in the water which owe their presence to contamination with air. A good way of making this determination is to prepare four gelatine plates with one c. c. of water on each plate; let two of them develop in a moist chamber and the other two in an atmosphere of hydrogen. When those exposed to oxygen are ready to count all four plates are examined and the number of colonies are estimated.

Experiments made in this manner, one with distilled water and one with Croton water show a great increase (over a thousand) in those plates kept in oxygen, and no increase in those kept in hydrogen. Afterward those which had been kept in hydrogen were transferred to the moist chamber, and they grew to as great a number as the previous plates kept in oxygen. Showing in result that they had not been killed by the hydrogen, but were unable to grow in that gas.

Bacteria capable of producing specific diseases are called faculative anaerobes. Some of these were found in the Croton water, and of the species which are derived from putrefactive organic matter of animal origin.

Plates prepared from sewage after a period of twenty-four hours were estimated that the air plates contained an average of 51,516 colonies, and the hydrogen plates 49,871 colonies. One c. c. of this sewage was put into a litre of sterilized water, the dilution bringing the number of bacteria down to about 260 per c.c. Upon standing for three days the plates showed 18,187 per c.c. for those grown in air, and 17,197 for those grown in hydrogen. These experiments show that the bacteria in sewage are probably facultative anaerobes, and that a considerable dilution of the water, although making it purer chemically does not stop the rapid multiplication of the bacteria.

All sewage that receives human feces contains bacteria called bacillus coli communis, or if it does not, it has at least been subjected to germicidal agencies, and it also contains putrifactive bacteria. A method of determining their presence is to add to about ninety c.c. of the water, ten c.c. of a ten per cent. pepton, five per cent. salt solution previously sterilized.

The mixture is made in a sterile Erlunmeyer flask provided with a cotton plug. A strip of paper washed with lead carbonate is suspended over the mixture, and the flask placed in an incubator at 37° C. for twenty-four hours. Under these conditions the colon-bacillus and the putrofactue bacteria readily multiply, and the latter cause the production of hydrogen sulphide, which discolors the paper. In order to detect the colon-bacillus a loop full of the above mixture after the twenty-four hours incubation, may be used for the preparation of a series of plate cultures in different stages of dilution, and from these plates there is no difficulty in obtaining pure cultures of that bacillus. The above procedures constitute those thought to throw the most light on the sanitary condition of a water.

ABSTRACT OF ASTRONOMICAL LECTURES.

GIVEN BY J. A. PARKHURST, '86.

A VERY brief abstract of the first four of the series of Astronomical Lectures, given by Professor Parkhurst in December, will be found in the December TECHNIC. We are able to abstract the remainder a little more in full, but still we will limit ourselves to a mere outline.

The seventh lecture was a continuation of lecture four and we will begin with it.

Time, Latitude and Longitude—Dec. 9.

Time. The rotation of the earth on its axis furnishes the unit of time, which is practically constant. According to Prof. Young, the rotation period has not changed by 0.001 second since the time of Ptolemy. Sidereal time is reckoned by the rotation with respect to the fixed stars, the vernal equinox of the heavens being the zero point and the sidereal time being always equal to the Right Ascension of the meridian. The error of the siderial clock is determined by transits of "time stars" across the meridian. Solar days, measured by the true sun, are of unequal length since the earth's orbit is an ellipse and the sun moves on the ecliptic. The equation of time is the amount to be added to apparent solar time to obtain mean time, the kind in common use. It varies from + 14m 32s about February 11, to — 16m 18s about November 2.

Latitude. The astronomical latitude is equal to the altitude of the celestial pole or the zenith distance of the equator point. The former is determined by taking the mean of the altitudes of a close polar star, at upper and lower culminations, corrected for refractions; the catalogue declination of the star need not be known, but the refraction correction is somewhat uncertain. The zenith distance of the equator point, or what is the same thing, the declination of the zenith, is found by measuring the difference of the zenith distances of a pair of stars, so chosen that their transits occur a few minutes apart, their zenith distances are small, opposite in sign, and nearly alike in amount. The declinations of the stars must be accurately known, but the difference of refraction is practically zero and the small difference of zenith distance depends only on an accurate spirit level and a filar micrometer. The resulting latitude is $\frac{\delta_s + \delta_n}{2} + \frac{\zeta_s - \zeta_n}{2}$ where δ_n and δ_s are the declinations and ζ_n and ζ_s the zenith distances of the north and south stars.

Variation of Latitude. Dr. Chandler has found that the earth's pole of rotation rotates around the pole of figure from west to east, with a mean period of 428 days, in a circle whose mean radius is 13 ft., the center of the circle moving from west to east with a period of one year, in an ellipse whose axes are 8 to 25 ft.

Longitude. The difference of longitude of two places is merely the difference of their local times. Where the places can be connected by telegraph two steps are necessary, first, each observer finds his local time very carefully; second, the times are compared by switching each clock in turn into circuit with the chronograph at the other station. The greatest source of error is the personal equation of the observer in finding long time. The observer must exchange places or determine their relative personal equation before and after the longitude work.

The Sun—Dec. 7.

The solar parallax, which is the angle at the sun subtended by the earth's equatorial radius, is about 8″.8, corresponding to a distance of 92,-897,000 miles, with an uncertainty of 100,000 or 200,000 miles. This is the unit for all celestial distances. The density of the sun is 0.255 times that of the earth.

The following envelopes are distinguished surrounding the sun's intensely heated interior. The Photosphere, the visible luminous surface consisting of matter more or less condensed. The spots and faculæ have their origin in the photosphere. The Reversing Layer, a shallow stratum of vapors of terrestrial substances, giving rise to dark absorption lines in the spectrum. The Chromosphere, an envelope of gases like hydrogen, calcium and helium, which are not condensed under solar conditions. The prominences are phenomena of the chromosphere. Finally the Corona, a vastly extended and extremely rare envelope of unknown gasses.

The solar surface is generally marked with dark spots, surrounded by penumbræ. These change from day to day, but sometimes last for months. They are found in zones from 5° to 45° of latitude, and in number and extent vary in cycles of 11.1 years. They give about $\frac{1}{40}$ the light of the photosphere and from $\frac{1}{2}$ to $\frac{1}{3}$ the heat. Their level is probably higher than the photosphere but lower than the surrounding faculæ. Their spectra indicate increased absorbtion by cooler vapors. The faculæ consist of photosphoric material more elevated, hotter and brighter than the rest of the surface. They are visible to the eye near the sun's limb, but, since they give bright line spectra, they can be photographed with the photoheliograph all over the surface.

The sun does not rotate as a solid body, the period at the equator being about 25 days, at latitude 75° about 39 days. In all latitudes the faculæ rotate faster than the spots, and the spots faster than the surface of the photosphere. This agrees with the theory of a contracting gaseous body.

About 40 terrestrial elements have been identified in the solar spectrum. Oxygen is suspected, but not proved.

The solar heat is probably maintained by contraction, 100 ft. a year in radius being sufficient. This would not be perceptible in the best telescope for centuries.

Moon, Planets and Comets — Dec. 8.

Moon. It seems to have a slight atmosphere, less than $\frac{1}{5000}$ that of the earth's. Its gravity is so small, $\frac{1}{6}$ that of the earth, that it could not retain an atmosphere of light gases. Occultations of stars are instantaneous, proving absence of any considerable atmosphere. Its surface features are: Dark Plains with smooth surfaces, like beds of ancient oceans; Mountain ranges, few in number, but with peaks as hign as 20,000 ft.; "Craters" or walled plains, 1 to 100 miles across, with walls 1,000 to 20,000 ft. high, suggesting extinct volcanic action, but on a much larger scale than terrestrial craters; Rills or "faults," often very straight, narrow and deep; Bright Streaks, radiating from the larger craters, level with the surface but reflecting more light.

During the long lunar day the surface temperature never rises as high as 0° C, at night it is probably –200° C. The light of the full moon is about $\frac{1}{600000}$ sunlight.

Slight changes on the surface have been suspected, but none proved.

Planets. Mercury, Venus, Earth, and Mars form the terrestial group of planets, similar in size and density. Little is known of the physical conditions of Mercury and Venus, but they are thought to rotate on their axes once during the revolution around the sun. As far as known both are without satellites.

Mars is most like the earth, the white spots at the poles, resembling snow caps, varying in size according to the seasons, which are like those on the earth. The surface seems to be quite flat, and the dark regions (seas?) and "canals" seem connected with the distribution of water from the melting of the polar snows. The canals are narrow and straight, and frequently four or five meet at a common point; the chance of such a meeting being accidental is very small. The two satellites of Mars, about 6 or 7 miles in diameter, are the smallest known permanent bodies in the solar system.

Jupiter, the largest planet, is most like the sun, having the same density and similar phenomena of surface rotation. Its dark and light belts give evidence of atmospheric currents circulating parallel to the equator. We see only the upper cloud surface, which changes slightly from month to month. Jupiter's four large moons were the first bodies discovered by the telescope, the fifth is the latest discovery, excepting the asteroids.

Saturn is unique in the solar system from its rings, which seem to have been left to show how worlds were made. They are not solid, but composed of small separate particles revolving in individual orbits, as spectroscopically proved by Keeler. Saturn is the lightest planet, it would float on water.

Little is known of Uranus and Neptune, the most distant planets. The revolution of their satellites is retrograde, unlike all other bodies in the solar system.

The discovery of Neptune is reckoned as the greatest triumph of the refinements of modern mathematical astronomy. Uranus failed to move in the path computed for it. This very small discrepancy furnished the data for the location of a disturbing body. The position was calculated, an observation made, and Neptune discovered.

Comets. The periodic comets revolve around the sun in elongated ellipses, the non-periodic pass through the solar system in parabolic or hyperbolic orbits. Comets contain hydrogen, carbon, iron, sodium, magnesium, and perhaps other metals. Their density is very slight, and the matter forming the tails is repelled from the sun by a force of unknown nature, perhaps electrical. The tails are often shattered, as if from the effect of some resisting medium in space.

Distribution and Motions of the Stars—Dec. 10.

The fixed stars are self-luminous bodies, comparable in magnitude with our sun. The nearest is separated from the earth by a distance at least 200,000 the radius of the earth's orbit, so that light requires 3½ years to come to us. They differ in magnitude (i. e. apparent brightness) both on account of size and distance from us. The most important work of the mathematical stellar astronomy is the formation of catalogues giving accurate Right Ascensions and Declinations of the fixed stars. Of 11,000 stars catalogued as double, a few hundred are probably "binary," that is, physically connected systems. The binary of shortest known period rotates in 5½ years. Periods of others are longer, up to some hundreds of years. The binary character of Sirius and Procyon was discovered by mathematics, from the influence of the companion on the motion of the primary. Several binaries have been discovered by the spectroscope, from periodic doubling or shifting of the spectral lines. These have periods from 4 to 104 days.

The annual parallax of the stars is the apparent shift of position due to the revolution of the earth in its orbit around the sun. The star Alpha Centauri has the largest parallax, 0″.86. The proper motion of the stars is "parallactic," due to the motion of the solar system in space, and "peculiar," due to the star's own motion. Some groups of stars, for instance the Pleiades, have a proper motion common in direction and amount. Their composition as shown by the spectroscope, is also similar. The largest annual proper motion is 8″.7, belonging to the star C. Z. C. 5h. 243.

The motion of the solar system in space is directed toward the constellation Hercules and is 10 or 15 miles per second. The best value of this motion is found from spectroscopic observations, which give the component in the line of sight, in miles per second, regardless of the distance of the star observed.

Constitution of the Stars and Nebulae—Dec. 10.

Our knowledge of the constitution of the heavenly bodies is derived entirely from the spectroscope. Huggins and Secchi, about 1860, first used this instrument in stellar observations. Secchi made a general survey of the heavens and divided stellar spectra into four classes, (types).

Type I. Hydrogen (dark absorption) lines strong and broad, solar lines (dark metallic lines such as are found in the solar spectrum) faint or absent.

Type II. Solar lines numerous. Most of the bright stars belong to this class.

Type III. Broad absorption bands, sharp on the violet end. About 500 stars belong to this class, including all the long period variable stars.

Type IV. Broad absorption bands, sharp on the red end. This class includes only a few stars, all red.

Gaseous nebulæ give a spectrum consisting solely of bright lines. Some stars give spectra consisting mainly of bright lines, suggesting a physical condition similar to the nebulae. Other stars whose spectra consist mainly of dark lines have the hydrogen lines bright, indicating an extensive atmosphere of glowing hydrogen. All gradations of spectra from nebular to solar, are found, showing various stages of development from nebulae to suns. The components of binary stars which differ in brightness, differ also in color and spectral type, the fainter star always having a color nearer the blue end of the spectrum and generally of spectral type I.

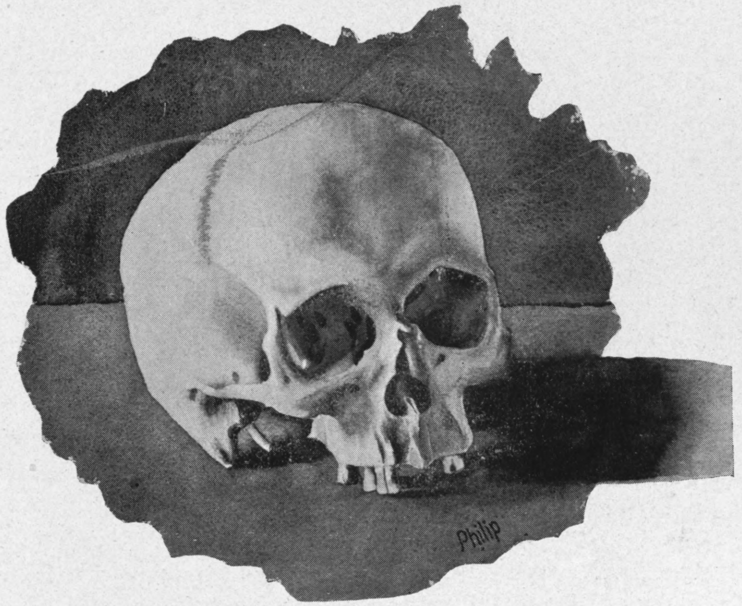
Different nebulae are annular, elliptical or spiral in shape, but no motion of rotation has yet been detected in them. Planetary nebulae show a disk like a planet. Nebulous stars have a stellar nucleus surrounded by nebulous matter. All these probably indicate different stages of development.

Definition of a school paper: A publication, to the contents of which *one* per cent. of the school contributes, and with which the remaining ninety and nine find fault.—*Ex.*

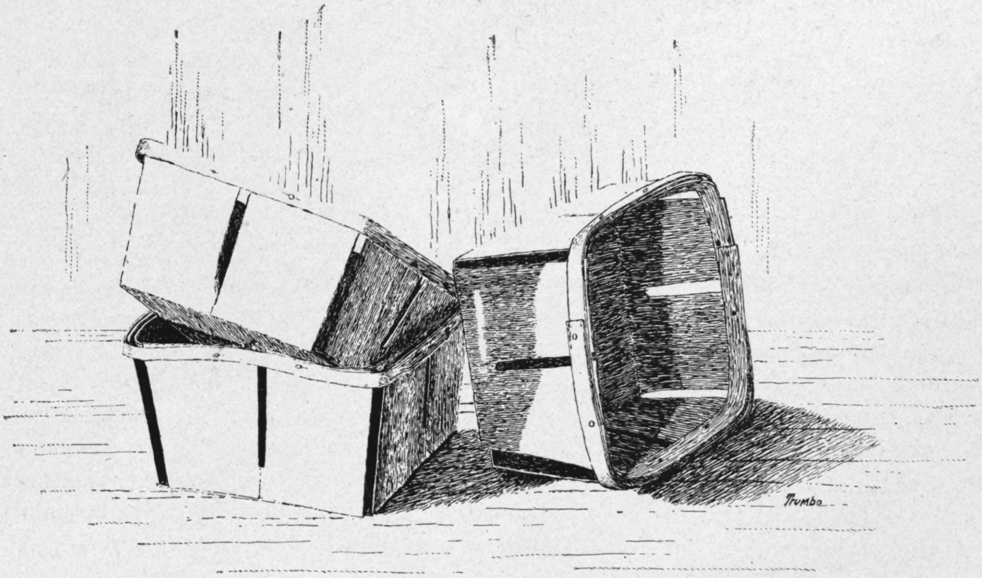
THE SOPHOMORE SKETCH BOOK.

On reviewing the several editions of Sophomore sketch books a complete history of the work done in free hand drawing is set before you. The work in free hand drawing covers a period of two years, reaching its climax during the latter part of the Sophomore year, at which time the students make pen and ink sketches of models or photographs; the sketches made are in nature the same as are used as originals for photo-engravings. Some time is also spent in making wash drawings, the work being of the same nature.

For an extended discussion of the objects in view in this work the reader is referred to THE TECHNIC, April, 1896, which contains an article by Prof. Peddle on this subject. Here it will suffice to say that the object of an Engineer making a sketch is to convey an idea, and that the habits of precision and accuracy are very much desired. It is not a finishing school for artists, but quite often a student develops considerable talent. The evolution of the process of illustrating by engravings is a very prominent feature of a review of the six sketch books which have been published. The advancement to the present photo-zinc engravings is quite as great as the difference between a wood cut and an engraving. The quality of paper is also very much improved. The classes of '88, '89, and '90, each published a sketch book in their Sophomore years, or rather these books were published by the Institute. In 1891 a book was published containing sketches from the classes of '91, '92, and '93; the subsequent publications were in 1894 of the work of '94, '95, and '96, and the one last June containing work from the classes of '97, '98, and '99. This practice is very good, for each class thus has a publication of its work while it is still in the Institute. The next publication will be in 1900 at which time the present Sophomores will be Seniors.



A few of the sketches of the last book have been reproduced in THE TECHNIC and it so happens that these were all the work of '98. Through the kindness of the Institute THE TECHNIC is able to reproduce a few of the remainder, '97 and '99 being for the above reason the only classes in evidence. In the last publications freehand work has entirely superceded the earlier practice of giving a few examples of instrument work. The cover designs are fine features of the last two sketch books. These designs are usually made by a member of the Sophomore class of the year in which the publication is made, but henceforth any Sophomore will doubtless have the privilege of making a competitive design if he so desires.



Wiley, '98, spent the holidays with Lansden, '98, in Cairo, Illinois.

Ford, '98, was in Louisville with Edwards, '99, during the vacation.

Professor Kendrick spent the holidays at his home in Newton, Massachusetts.

At last the new lockers are in place in the Gymnasium and are ready to be used.

Mr. Harris paid a flying trip east and spent a few days in Buffalo during the vacation.

'Arry is still looking for the man that called to him to come quick, "the grind-stone has a hot box."

Dickerson, '01, has been elected Secretary of the Freshmen class to fill the place left vacant by Insley.

A Mandolin Club has been mentioned several times of late. It is hoped that an organization will be effected.

McLellan attempted to light the gas with a loaded "Christmas" match the other evening. A stampede was narrowly averted.

1st Senior: "What's your excuse for being absent to-day?" 2nd Senior: "Heard Nansen last night and caught a severe cold."

Mr. Harris has become a camera fiend and we hope he will use his influence to revive the Camera Club, which has been dead since last spring.

Professor Wickersham was quite cordial in his greeting to the Freshmen after the holidays: "Well, I'm glad to see that you wern't badly slaughtered."

Professor McCormick introduced the Freshmen to a few differentials the other day, after which Dickerson asked: "Is that algebra, trigonometry or quaternions?"

It is quietly whispered about that Larson, '00, is greatly interested in the culture of "School Ma'ams;" the proximity of the Normal is very fortunate for him.

Dr. Mees was interrupted by the ringing of the telephone bell while talking to the Juniors: "Wait just a minute while I find out which young lady wants you."

Professor Faurot: "How many have copies of 'William Tell?'" Madison: "Professor, I have an old one, but there is one objection—it has the English under the Dutch."

Insley, '01, has decided to give up his work at the Rose Tech, and will prepare himself the remainder of this year to continue a course in law at Leland Stanford next year.

The Sophomore Electricals and Mechanicals will continue in the machine shop until Feb. 1st, after which half of the practice time will be devoted to the electric laboratory.

York, '00, was heard to ask, in a chemistry lecture, what was the formulæ for the odor of garlic. When the class laughed he explained that he could not remember the formulæ of all the elements.

It has been suggested that the Institute provide some additional excuse blanks with the printed elastic statement: "Temporarily indisposed; mark me unexcused." They would be of service to the "Chronics."

Some one has remarked that the new absence blanks will be presented to the faculty meeting, who will sit upon the merits of the excuses, but it seems more likely the man will be sat upon unless new excuses are coined.

Heard in the library: "I don't like this new system of getting absences excused; you have to put it down in black and white and sign your name. Before you only had to say yes to some of the questions Dr. Mees asked."

McLellan was deeply involved in a problem in the photometry room when interrupted by the opening of a door. With his rare commanding voice raised to its highest pitch, he called: "Shut that door and be quick about it." He did not notice that Dr. Mess was on an inspection tour.

Trumbo says that he can't see how his boarding house Mistress can make any money. Each fellow gets away with at least ½ lb. beefsteak, 6c.; 3 potatoes, 1c.; ½ loaf bread, 3c.; ½ pie, 5c.; 4 apples, 4c, to say nothing of extras, making a sure loss to the landlady.

The Junior Civils wanted a "Finis" for their railroad maps, so they selected the C. & E. I. train pulled by engine "99." The operator at Tenth and Locust streets was interviewed and kindly telegraphed to the engineer of the train what the boys wanted. When the train had arrived and was backing from the depot to the yards, the engineer kindly brought his train to a stop and furnished the boys an excellent "pose" for a photograph.

President Mees, Dr. Gray, Dr. Noyes, and Professor Hathaway, attended the meeting of the Indiana Academy of Science, held at Indianapolis, Dec. 28–29. Dr. Gray, as President, delivered the presidential address, an abstract of which is given in this issue. Dr. Noyes presented a very interesting paper on "Camphoric Acid." Professor Hathaway presented a paper on "Alternate Processes in Mathematics." Dr. Gray also read a paper prepared by Lendi, '97, on "New Forms of Galvanometers," being the result of experiments on a new galvanometer which Lendi has just completed in the laboratory.

LECTURES.

The course of lectures which were delivered last term on Astronomy, will be followed by a series of lectures during the present session on topics of a general nature, covering the branches taught in the Institute. From the partial list given below the series promises to be of unusual interest. The full course lectures for this term have not as yet been announced, but the first six lectures will be as follows:

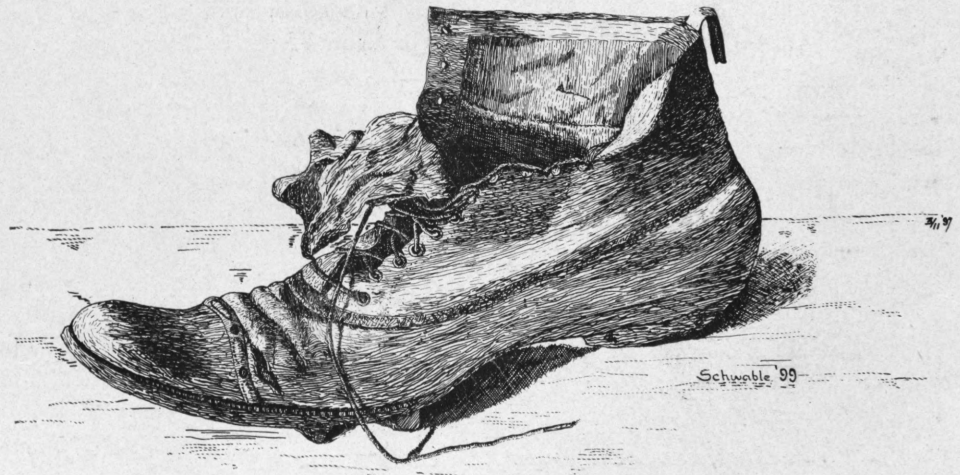
Jan. 27th — Professor Wagner — "Historical Sketch of the Development of the Steam Engine."

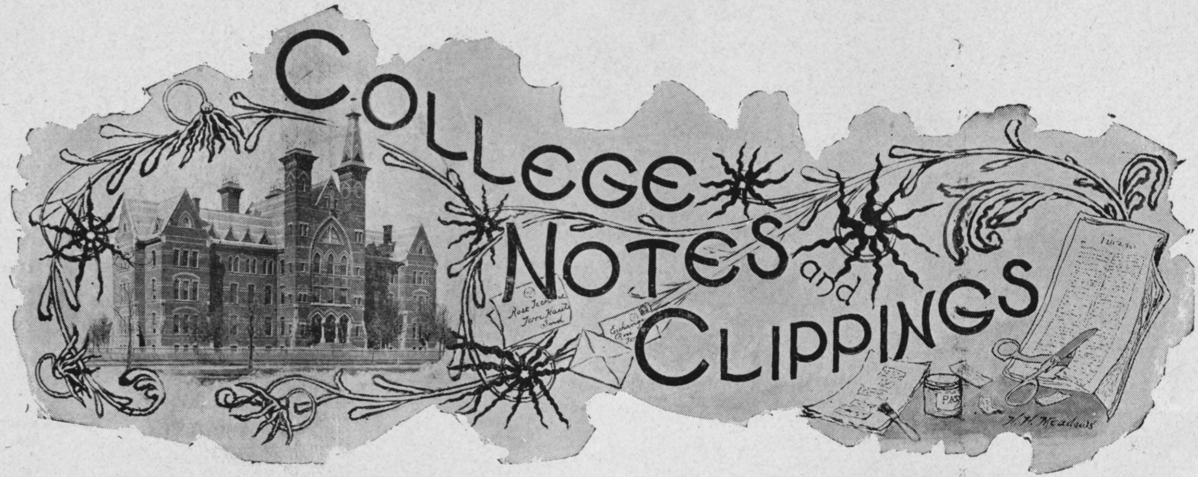
Feb. 10th — Dr. Noyes — "Water Supply from the Chemical and Bacteriological Standpoint."

Feb. 19th — Professor Howe — "Arches Used in Bridges."

March 1st — Professor Peddle — "Development of the Steam Pump."

March 18th — Professor Kendrick — "Michael Faraday."





The receipts of the Pennsylvania-Lafayette game amounted to $12,000, $4,000 of which goes to Lafayette.—*Ex.*

Yale annually buys $7,000 worth of books for her library. Harvard spends $16,000 and Columbia $43,000.—*Ex.*

Mount Holyoke College now has an electric course in journalism, including lectures by an experienced journalist.—*Illini.*

At the Syracuse University meeting recently, Princeton broke the broad jump record with a jump of 22 feet, 6½ inches.—*Wabash.*

President Eliot of Harvard, prophesies that college fraternities will in time cause American Universities to be broken up into colleges after the English plan.—*Miami Student.*

The *Georgia Tech* contains among other interesting articles, a well written article on the "Manufacture of the Incandescent Lamp" as practiced by the General Electric Co., at Harrison, N. J.

"Above all things, be enthusiastic in your work; be interested in all the meetings connected with your college. Be loyal to your little college world in all its enterprises and proud of its achievements. In other words, be a part of it in its joys and trials."—*Earlhamite.*

Lack of space prevents our mentioning more than the names of the new exchanges placed on our table for the first time. Among these are *The Polytechnian*, *The Vincennes*, *Mount St. Joseph Collegian*, *Vanderbilt Observer*, *The Tahoma*, *The Orator*, *Purdue Exponent*, *The Polytechnic*, *and The Fulcrum.*

The exchanges for the holidays are all remarkably good, many show a great improvement both in the contents and the manner in which presented. Some of the articles contributed by the students show ability as story writers. The Xmas stories are, of course, in the majority, and deserve praise.

In looking over the exchange for the last month we are struck with the severe criticisms indulged in by some of the exchange editors. Criticism in its place, when just, is much desired, but there seems to be a lack of the true appreciation of the duties of the critic, not only to find fault but to point out and give credit for the fine points, as well. The college magazine is by no means the standard of literary production in the college world. Often, and indeed in many cases the consultations are from young and inexperienced writers who have not formed a distinctive style of their own, and are using the pen for the first time. In such cases severe criticism often throws a cloud over future efforts. The duties of the exchange editor are peculiar to each individual publication and a standard cannot be raised by which all shall be governed, but there is one thing that can always be remembered, that it is better to say a word for the good qualities than to search for errors which will be found among even the best of writers.